Pseudo-rapidity Asymmetry of Charged Hadron Spectra in d+Au Collisions at $\sqrt{s_{NN}}$=200 GeV

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The suppression of high transverse momentum (p_T) particles in central Au+Au collisions at the Relativistic Heavy-Ion Collider (RHIC) can be explained by both final state and initial state effects, such as particle energy loss or parton saturation. The measurement of particle production at mid-rapidity from deuteron-gold (d+Au) collisions at RHIC favors the scenario that the suppression of high-p_T particles is primarily due to the final state interactions, i.e., processes after the hard partonic scattering. The Cronin effect[1], the enhancement of particle yield with respect to binary collision scaling, has also been observed in d+Au collisions. The conventional explanation of the Cronin effect is that it is due to multiple scattering of projectile partons by the target nucleus before the production of a minijet by a hard scattering. Measurements of charged hadron production in d+Au collisions can be used to investigate the underlying mechanism, conventional and otherwise, responsible for the Cronin effect.

Particle production in d+Au collisions from soft and hard scattering processes has distinctive rapidity and centrality dependences. For partonic processes such as the dominant $g+g$ and $q+g$ scatterings at intermediate p_T the particle rapidity distribution can be evaluated in a QCD-inspired framework which depends on the parton distribution functions and the underlying dynamics. For example, calculations of the Cronin Effect from parton multi-scattering and independent fragmentation [2] predict a unique rapidity asymmetry of particle production in d+Au collisions where the backward-to-forward particle ratio will be greater than unity at low p_T , go below unity at intermediate p_T and approach unity again at high p_T . Recently, the parton recombination model was used to explain the Cronin Effect as a final state effect [3], implying a backward-to-forward particle ratio markedly different to that of the QCD-inspired formulation in [2]. Backward-to-forward particle ratios in d+Au collisions can identify the processes that give rise to the rapidity asymmetry in d+Au collisions as well as differentiate between initial- and final-state paradigms as the origin of the Cronin effect.

Inclusive p_T spectra of charged hadrons over a η range of -1 (*Au*) to +1(*d*) in d+Au collisions at $\sqrt{s_{NN}}$=200GeV were measured using the STAR Time-Projection Chamber (TPC). We define a measured asymmetry by taking ratios of backward (*Au*-side) to forward (*d*-side) rapidity inclusive p_T spectra. Figure 1 shows the p_T dependence of the asymmetry for minimum bias events. The ratio was taken between the -1.0< η <-0.5 and 0.5< η <1.0 as well as -0.5< η <0.0 and 0.0< η <0.5 regimes. Particle production at mid-rapidity in d+Au collisions may include contributions from deuteron-side partons which have experienced multiple scatterings while traversing the gold nucleus, and from gold-side partons which

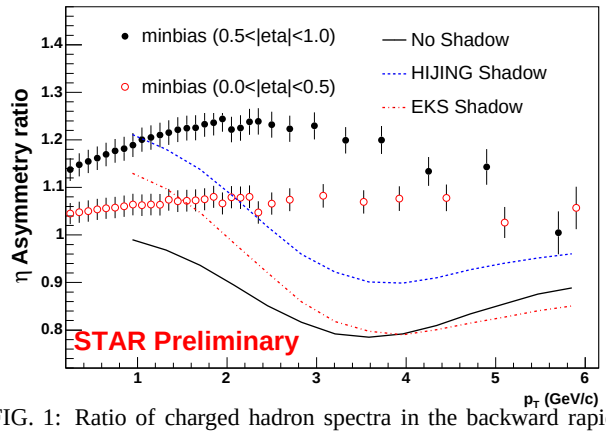

FIG. 1: Ratio of charged hadron spectra in the backward rapidity to forward rapidity region for minimum bias events. Calculations from pQCD are also shown for the no shadowing case (solid curve), the case that uses the HIJING shadowing mechanism (dashed curve), and the EKS shadowing case (dot-dashed curve).

may be modified by nuclear effects. Also shown in Figure 1 is the calculation of the asymmetry in the parton multiple scattering framework with various nuclear shadowing parameterizations. The ratio, taken for minimum bias spectra at y = -1 and y = 1, is below unity at $p_T \sim$ 3-4 GeV/c and is a consequence of the increase in p_T for partons from the deuteron hemisphere. Our measurement disagrees with the theoretical calculation [2]. In the intermediate p_T region, multiple scattering of partons in the initial state alone cannot reproduce the observed pesudo-rapidity asymmetry.

In conclusion, a phenomenon as pertinent to high-energy heavy-ion collisions as the Cronin effect is not yet reasonably understood. The conventional explanation behind the Cronin effect (as implemented in [2]) does not adequately describe it. Given the expected qualitative agreement between the observed pseudo-rapidity asymmetry in d+Au collisions and the recombination model it is possible that the Cronin effect is a consequence of final state effects. Future theoretical work is necessary in order to identify the relevant mechanism behind the Cronin effect, the understanding of which is critical to the disentanglement of known physical effects from novel phenomena in Au+Au collisions.

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